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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Does discharge time source correspond to its geographic source in hydrograph separations? Toward identification of dominant runoff processes in a 300 square kilometer watershed" *by* Y. Yokoo

Y. Yokoo

yokoo@sss.fukushima-u.ac.jp

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Thank you for your comments and suggestions to my manuscript. My responses are in the followings.

General Comments

The main aims of this study are to compare End Member Mixing Analysis (EMMA) and numerical filters in hydrograph separations in a large catchment. The chosen

study site is the Abukuma River catchment in Japan, although the results are most likely applicable to other similar catchments worldwide. The paper is clearly written and generally well structured and deals with the subject matter in a logical order. The topic is of broad general interest to the hydrological community and falls well within the scope of HESS. I am unsure whether the definitions of the various techniques are clear and meaningful. Both are based on time series data. To avoid confusion it would probably be better to refer to something more specific (e.g. filtered hydrograph data and chemical mass balance) such as is used in the text (e.g., in Section 2.3). The terminology also seems to subtly change at places within the manuscript and it is important to use the same terms throughout to not confuse the reader.

RESPONSE:

Thank you for your suggestion. I would use the same terms throughout in the revised manuscript.

One main scientific concern is with the EMMA; firstly turbidity is not a good parameter as it is not conservative and secondly the derivation of end-members is done only by reference to data from the river with no independent verification. Despite statements to the contrary, some verification is required and should not be beyond the scope of the research.

RESPONSE:

Thank you for your suggestion. Firstly, I would describe limitations in using EC and Turbidity as tracers used in the EMMA. A complete verification would not be possible, but I would carefully discuss for this aspect and methodological limitations in the revised manuscript.

The choice of the filtering technique also needs more justification. It is relatively easy to process hydrograph data with filters or other techniques and it would be not a difficult task and it would lend more weight to the conclusions.

RESPONSE:

At least, I would add more explanations for my selecting the filter separation by Hino and Hasebe (1984). My weak explanation for selecting this method is also pointed out by other reviewer. I believe Hino and Hasebe (1984) is the best method at least for my research, yet I would carefully select other candidate so that I can introduce results by other numerical separation method.

There is also tendency to focus on the numeric aspects such that it is not always clear what the physical meaning of the 5 flow components or the lag is. It may be fine to get these results from processing of the data, but to be useful and convincing; you need to be clearer about how this relates to actual processes. The time lag in particular seems arbitrary and very long.

RESPONSE:

Your opinion is right and my explanation was not enough. I would add more explanations for this part in the revised manuscript for potential readers' benefits.

Overall, while this is potentially a valuable study, I think that it needs more work prior to publication.

RESPONSE:

I would try my best to revise the manuscript to meet your suggestions.

Specific comments

There is some confusion as to the size of the catchment (I think that 3000 km2 as in text not 300 km2 as in the title is correct).

RESPONSE:

It was my mistake. Correctly, it is 3000 square km I would be more careful in submitting the revised manuscript.

Abstract

The abstract is a good summary of the paper and conveys the main aims and results of the study without need to refer to the text.

RESPONSE:

Thank you for your comment. I would also be careful for the abstract in revising manuscript.

Introduction

This is a good summary of the relevant literature; however, in places it lacks detail and doesn't convey what is really important. âËŸA′c Page 10933, lines 4-15. This would not be very clear to anyone who had not read the individual papers. Please explain how the several components may be distinguished. âËŸA′c Page 10933, lines 20-30. The significance of using geochemistry to do something other than calibrate the results of numerical techniques needs a bit more explanation. Basically it is because most techniques lump several water components into quick flow and slow flow (or baseflow) but do it differently; so delayed water such as bank return flows that is geochemically similar to surface water may be grouped with baseflow in a numerical filter but surface flow if chemical mass balance is used. This needs explaining a bit more fully as it may not be appreciated by all readers. âËŸA′c Pages 10933-10944. In places you are presenting a list of techniques or a historical perspective. It would be better to explain the important points of these techniques – what are their advantages and disadvantages? where do they "fail"? etc. There are probably a few aspects that you need to discuss in the introduction to properly frame your paper. These could include âËŸA′c An explanation of the general situation that most techniques split river discharge into two components (quick flow and baseflow) but that those components may be made up of different waters (e.g. baseflow can be groundwater, bank return flows, drainage of floodplain pools etc). âËŸA′c The issue that the various techniques commonly give different answers and whether this is a problem or whether applying multiple techniques

can give us com-plementary information. âËŸA´c It would be good to start the introduction with a short statement of why we care about determining groundwater inflows or total baseflow to streams.

RESPONSE:

Thank you for your suggestions. I would revise the introduction so that I can convey what is important in the revised manuscript.

Data

The data for this project are from a public source, so details on their collection are probably not relevant, some minor points: âËŸA´c Are Temperature, pH, and DO used in this study, if not you can omit them here? âËŸA´c How were the record processed for data gaps (were the gaps ignored or did you try to estimate the data?) âËŸA´c I am not sure what the turbidity units are (deg?) I'm used to seeing these in Nephelometric Turbidity Units (NTU)

RESPONSE:

I would consider omitting them in the revised manuscript and explaining that I have ignored the data gaps. The unit is correct.

Study area (section 2.1)

This is very short and it is difficult to get a clear picture of what the catchment is actually like. Please provide some more details on the landscape, hydrology, rainfall, groundwater etc.

RESPONSE:

I would provide more details in the revised manuscript.

Filtering (Section 2.3).

There are several possible choices of filtering techniques; is there any specific reason

why this one is chosen. It would be interesting to compare the results of this technique with other numerical filters or other techniques based on the hydrograph.

RESPONSE:

Yes, there was. As I mentioned above, this method was best for my research as the key parameter, recession time constant Tc, can be decided from hydrograph alone, allowing data-based modeling that simply capture the nature of the watershed. Yet, as you pointed out, it may be more interesting to include the result of other numerical filters, hence I would consider to do it in the revised manuscript.

Results

Section 3.2. I am not convinced that you have enough geochemistry data to do the EMMA in the way that you have. EC will likely work as a parameter, but to be convincing about this you need to say something about the major ions. For example if Cl is the major anion it is likely to be conservative and EC will probably not change in the river by any other process than addition from baseflow or evaporation. However if nitrate or bicarbonate are the major anions then EC values may not be conservative and may change due to in-river processes.

RESPONSE:

Thank you for your comment. I would check the major ions in our study area so that I can discuss on this regard.

Turbidity is more of a problem and is certainly not a good choice of parameter. While Fig. 3 can be interpreted as a three component mixing plot, there is the assumption in doing this that mixing of water from the three sources is the only process. For EC that might be OK (see above) however as particulates settle out from streams, the turbidity is almost certainly modified during river flow; in which case, Fig. 3 cannot be so simply interpreted.

RESPONSE:

Your process based explanation is completely right and this point is also raised by other reviewer. I used Turbidity as a tracer of quick flow that originates from near surface zones of the watershed. Actually, suspended solids, that should be equivalent to Turbidity, may settle down to the riverbed in low flow condition and they can float and flow again in high flow condition. Yet, I have more macroscopic view for the Turbidity variation in the relatively large watershed that covers as much as 3000 square kilometers. For example, we know that the color of river water get brown in high flow condition, whereas it become clearer in low flow conditions. I intended to capture these simple process changes via turbidity. In that sense, identification of end-member is not a critical issue, but rather using the frame work of EMMA to use mass balance equations was more critical in this research for a 3000 square km watershed. I would clearly discuss these points in the revised manuscript.

I am also concerned that there are no independent end-member data. For example do the supposed EC values of the groundwater and surface water match with observations in the catchment? This section needs far better justification as the EMMA results critically depend on it.

RESPONSE:

I would try to find the data that can justify the supposed end-members. As mentioned above, this research does not pay special attention to the values and their meanings of end-members, yet I would try to justify my results in the revised manuscript.

What is the justification for the 66 day lag? I can imagine that some smoothing of the geochemistry data to take into account the time taken for river transport from the distal part of the catchment might be necessary but this seems very long. It looks as if this was chosen for numerical convenience, is this the case or do you think that it has physical meaning? It may be that the lag relates to the delayed rise in the water table after rainfall, but if that is the case you would need to have some data to verify it.

RESPONSE:

Thank you for your thoughtful comment. I derived the magnitude just numerically, but as you mentioned, there must be physical reason. I would try to search the physical meaning for this lag time so that I can mention it in the revised manuscript.

Section 3.4.

This section compares the results, but I think that it needs to do more. Firstly, there needs to be some indication of the uncertainties and limitations of each technique (especially given the questions about whether turbidity is useful). I also found it difficult to follow the discussion. Defining Q1 to Q5 is all very well but what do you think that these components actually are in terms of water stores. A study like this is valuable if it can be related to physical processes. You do discuss this at the end of the section, but a clear explanation earlier (or in sections 3.2 and 3.3) would have helped.

RESPONSE:

I would surely add some paragraphs that describe uncertainties and limitations of each technique not to mislead the potential readers of this manuscript. As for the definitions of Q1 to Q5, I agree with your opinion. I would explain more in sections 3.2 and 3.3 in the revised manuscript.

Section 4.1

I can't help but think that there is a lot of circularity here. The EMMA has been adjusted by using a lag time so that it agrees with the filtering so it is not surprising that they agree (i.e. the agreement doesn't appear to be a very independent test). These latter sections are really only valid if the EMMA and filtering results are themselves valid. Given the questions raised above, I would have liked to have seen a more thorough justification of the results in these sections; as it is this section is very general and does not add a lot to the confidence of the study.

RESPONSE:

Thank you for your comment. I would reconsider this section and the message of

this manuscript to increase the degree of justification for my discussions in the revised manuscript.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 11, 10931, 2014.